Glenn Research Center Environmental Programs Manual

Chapter 15 – Life Cycle Assessment

NOTE: This new Chapter is created, maintained and approved by the Environmental Management Office (EMO). The creation date for this chapter is September 2003. The current version is maintained on the Glenn Research Center intranet at http://osat-ext.grc.nasa.gov/emo/pub/epm/epm-contents.pdf. Approved by: EMO Chief, Michael Blotzer {mailto:Michael.J.Blotzer@nasa.gov}

PURPOSE

This chapter establishes policies and procedures for applying life cycle assessment principles to facility operations. This strategy will be applied when the Affirmative Procurement/Environmentally Preferable Purchasing (AP/EPP) program is not adequate to guide purchasing decisions for GRC operations. This chapter does the following:

- Describes the status and current policy for sustainable design / life-cycle costing and assessment policy and requirements for GRC buildings, structures and facilities including the environmental, energy and water costs of construction, purchase, renovation, ownership, operations and maintenance
- Establishes life-cycle costing and assessment policy, procedures and requirements for all operations at GRC that are not addressed by the sustainable design policies, nor adequately addressed by the AP/EPP program.
- Promotes life-cycle assessment /accounting and sustainable design activities throughout the facility by all employees and contractors
- Delineates the roles and responsibilities of individuals, teams and organizations necessary to implement this program
- Establishes program metrics and evaluation procedures
- Supports EMS goals including resource allocation for cost effectiveness

APPLICABILITY

This chapter applies to all personnel at the GRC including civil servants and contractor employees.

DEFINITIONS

Life cycle assessment (LCA)
LCA refers to the comprehensive examination of a product's environmental and economic aspects and potential impacts throughout its lifetime, including raw material extraction, transportation, manufacturing, use, and disposal Executive Order (E.O.) 13101. The International Standards Organization has defined the life cycle assessment slightly different as follows: Compilation and evaluation of the inputs, outputs, and the potential environmental impacts of a product system throughout its life cycle. The use of the term in this document will imply that the intent of both definitions will be satisfied within this policy.

Life cycle cost
The amortized annual cost of a product, including capital costs, installation costs, operating costs, maintenance costs and disposal costs discounted over the lifetime of the product (OMB Circular A-94 and E.O. 13101). However, this definition does not include external costs (those not borne directly by the entity that owns and operates a product/service, such as environmental costs to society at large). The EPA encourages agencies to consider all internal and external costs associated with a product, process or activity throughout its entire life cycle – from raw materials acquisition to manufacture, recycling and final disposal. For the purpose of this policy, life cycle costs will include all internal costs, as well as any external costs that can reasonably be included in the assessments. The extent to which external costs are evaluated is likely to increase as better costing tools become available for general use (E.O. 13123 and 10 CFR 436.19).

Life cycle cost-effective
Refers to the life cycle cost of a product, project, or measure that has been estimated to be equal or less than the current or standard practice or product (E.O. 13123 and 10 CFR 436.19).

Sustainable design (SD)
Refers to an over-arching concept incorporating appropriate sustainable design elements into facilities planning, design, construction, operation and maintenance enhance and balance facility life cycle cost, environmental impact, and occupant health, safety, security, and productivity. The essential elements of NASA's Facility Sustainable Design (NPD 8820.3) include:

- Energy efficiency and water conservation
- Site selection to minimize environmental and transportation impact, and if possible, to enhance the environment
- Use of sustainable materials (reused, recycled, recyclable, non-toxic, low embodied energy content, renewable)
- Emphasis on durability and efficiency of materials and equipment
- A healthy environment, not limited to, indoor air quality
- Features in support of enhanced worker productivity
- Design for personnel safety and security
- Design for decommissioning and disposal
- Enhanced building operating and maintenance characteristics
- A philosophy that defines operational objectives, then tests and verifies that all building systems and components have been properly installed and perform to the level intended

BACKGROUND

The NASA Glenn Research Center (GRC) is committed to environmental protection consistent with environmental laws and regulations, Presidential Executive Orders (EO's), the Federal policy on "Greening the Government", NPD 8500.1 *Environmental Excellence for the Twenty-First Century*, other NASA policies and the GRC environmental policies and programs.

GRC has adopted an environmental policy as part of the recently adopted Environmental Management System (EMS), which states:

"GRC operates in a manner that preserves and protects the environment through pollution prevention, the continual improvement of our operations, and complying with regulations".

The GRC Environmental Programs Manual further delineates this policy and all related implementation strategies. Successful implementation of this pollution prevention plan is a high priority goal for GRC.

NASA Procedures and Guidelines (NPG) documents that pertain to the life cycle assessment plan include the policy NPD 8820.3 Facility Sustainable Design, NPG 8820.3 Pollution Prevention and NPG 8830.1 Affirmative Procurement Plan for Environmentally Preferable Products. This plan will be revised annually or more often to address new requirements promulgated by regulatory agencies or established by NASA HQ and GRC.

NASA's sustainable design NPD 8820 policy describes the strategy for implementation of life cycle costing incorporated into the daily decision-making process. However, the development of the sustainable design program is an ongoing agency-wide effort being lead by NASA HQ. In the interim, all NASA engineers and architects, as well as contractors, are encouraged to apply the principles of life cycle costing and sustainable design, as described in this chapter, to the extent practical regarding buildings, new construction, renovations and other facilities modifications.

The programs established and implemented by this plan will be closely integrated with the Pollution Prevention (P2) and Greening the Government (GTG) Chapter 6 and the AP/EPP Program new Chapter 39 coming soon. Purchasing products off the AP/EPP listings will automatically incorporate life cycle strategies into a project or operation.

A set of generic life cycle assessment, analyses and costing tools and procedures have been developed which can be used to compare the life-cycle costs of various alternatives for a given project. Both a qualitative assessment and a quantitative cost analysis are needed to cover the full range of life cycle issues. The generic tools developed Appendix A and B includes a Project Description page, an LCA Issues page (to be completed by the LCA program developer), a Qualitative Assessment Matrix page, a Qualitative Assessment Matrix page, and an LCA Summary Matrix page in an electronic spreadsheet file. The qualitative assessment addresses how well the proposed item/activity options meet life-cycle criteria that are not easily expressed numerically. However, this evaluation might provide evidence of a clear preferred option. If needed, a more detailed quantitative analysis, which includes the key metrics of inputs and outputs of an operation can be conducted. This analysis will provide a numerical evaluation of the life-cycle cost effectiveness for each project alternative studied. Combining both a qualitative assessment and a quantitative evaluation into a summary matrix provides insight useful in making life cycle conscious decisions.

POLICY

GRC employees and contractors will use life cycle assessments in project design phases and for procurement decisions to the extent feasible and practical.

REQUIREMENTS

Several Presidential Executive Orders (EO's) place life cycle costing requirements upon federal facilities, including NASA GRC:

- EO 12845 which requires the purchase of energy efficient computer equipment
- EO 12856 which requires the preparation of a written pollution prevention plan and the development of goals to reduce their use and releases of toxic chemicals
- EO 12902 which promotes water conservation and energy efficiency
- EO 13101 which requires waste prevention and recycling activities be incorporated into facility operations, and encourages the expansion of markets for recovered materials by establishing a preference for recycled products by federal facilities
- EO 13123 which establishes goals for energy efficiency and greenhouse gas reduction, directs energy consumption reduction measures, promotes renewable energy projects, and requires reductions in the use of petroleum products and water consumption
- EO 13148 which establishes P2 policies and environmental compliance audit programs, promotes management practices, and sets reduction targets and goals for persistent, bioaccumulative and toxic (PBT) chemicals, Toxic Release Inventory (TRI) releases and ozone-depleting substances
- EO 13149 sets goals for the reduction of petroleum consumption by motor vehicle fleets

Guidance documents have been provided in responses to the above requirements. These NASA guidance documents provide a more detailed description of the requirements for GRC:

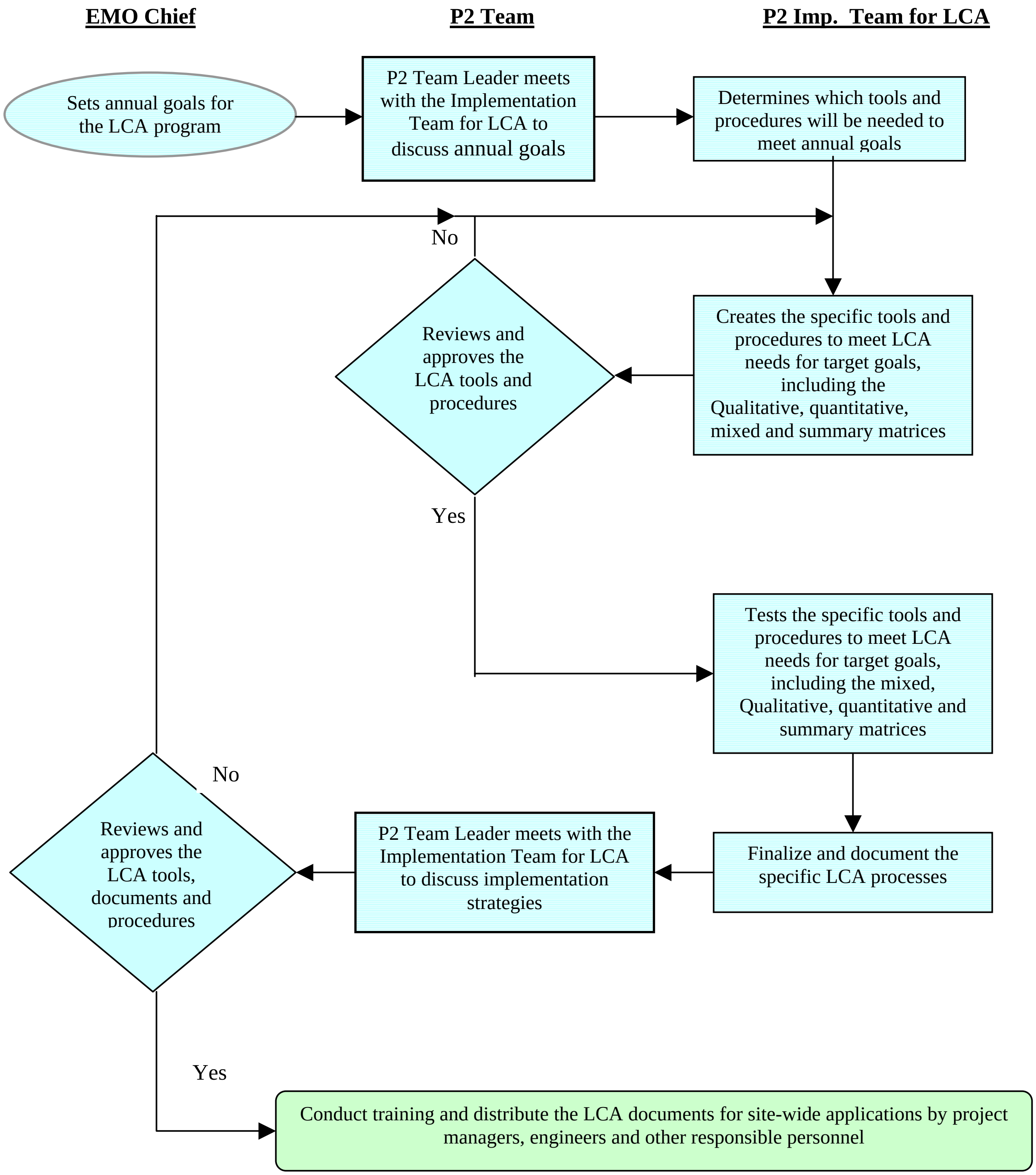
- NASA Procedures and Guidelines NPG 8820.3, "Pollution Prevention", March 1 1999 to March 1, 2004
- NASA Procedures and Guidelines NPG 8830.1, "Affirmative Procurement Plan for Environmentally Preferable Products", February 1 1999 to February 1, 2004
- NASA Policy Directive NPD 8820, "Facility Sustainable Design"

PROCEDURES

The AP/EPP Program should be consulted prior to initiating the LCA procedure. The AP/EPP lists may include off-the-shelf items that have been pre-screened through a life-cycle evaluation when second life-cycle analysis would not be required. However, there will be products, equipment, and activities that have not been evaluated through the AP/EPP program. In these cases, a life cycle assessment may be required that will be project / activity / equipment specific. This evaluation is very likely to require considerably more effort than the use of the AP/EPP lists. The life cycle assessment procedures will be established, tested, and modified to best meet the priority life cycle goals of each specific activity (see LCA Tool Development Procedure flowchart), while minimizing the level of expertise, time and effort needed by the project manager to complete the life cycle study.

Implementations of life cycle principles are the responsibilities of GRC employees and contractors. The Sustainable Design procedures (Appendix A) will be applied when possible (see Life Cycle Procedures flowchart). Those with responsibility for activities / projects / equipment selection will apply either the Sustainable Design procedures or the LCA procedures during the conceptual design phase of their projects.

LCA Tool Development Procedure



The development and test implementations of the various life cycle tools will be performed by or coordinated with the P2 Implementation Team for LCA, following the procedures outlined for P2 activities in Chapter 6. Accepted life cycle assessment procedures will be included in a growing set of life cycle analysis tools. Such life cycle tools will be condensed for use by engineers, architects and project managers – with minimal information input requirements (see Life Cycle Procedures for Project Evaluators). These tools will be available electronically, with instructions for their use, to the personnel assigned the life cycle assessment responsibilities. The project manager will submit the completed life cycle assessment files to EMO, and EMO will maintain records of these assessments.

The other roles and responsibilities of key individuals are described below:

Project Managers, Engineers and Responsible Personnel

- All civil servants, contractors, academic visitors and other GRC personnel that have responsibilities as a project manager/engineer will be required to prepare a life cycle assessment of any new project/activity/ equipment at GRC. This assessment will not be required if the equipment can be purchased from the AP/EPP lists, or if the project / activity would be evaluated under the NASA HQ sustainable design criteria.
- Must include all feasible options being seriously considered for the project / activity in the life cycle assessment.
- Must utilize the appropriate life cycle assessment tools for their category of project / activity / equipment, but are not required to develop any new tools as part of the assessment
- Must submit the completed life cycle assessments (SD and LCA results) to the P2 Committee Lead to meet NASA HQ reporting requirements
- Report to the life cycle team any perceived shortcomings in the life cycle assessment procedure or tools

Facility Personnel

- All civil servants, contractors, academic visitors and other GRC personnel will cooperate with the life cycle assessment efforts at GRC

RECORDS

The P2 Committee Lead maintains a record of life-cycle assessments performed at GRC.

The P2 Committee Lead will prepare a report of life cycle activities to satisfy the reporting requirements to NASA Headquarters through the NASA environmental tracking system (NETS).

The P2 Committee will prepare a quarterly report of life cycle activities to the NASA Environmental Pollution Control Board and the Chief of EMO.

REFERENCES

42 U.S.C. 13101 et seq., the Pollution Prevention Act of 1990

Executive Order 12843, “Procurement Requirements and Policies for Federal Agencies for Ozone-Depleting Substances” (revoked by EO 13148)

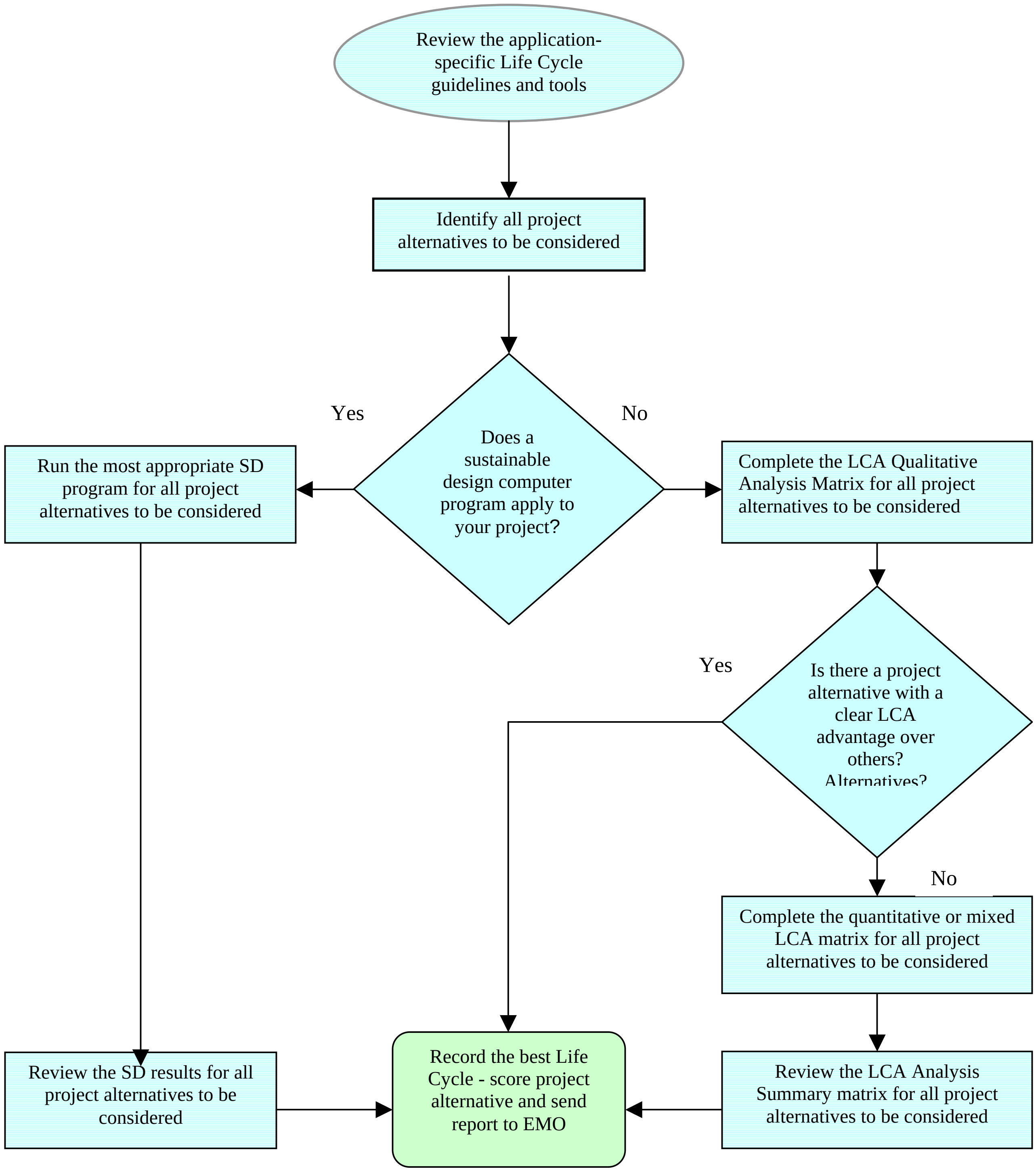
Executive Order 12844, “Federal Use of Alternative Fueled Vehicles”

Executive Order 12845, “Requiring Agencies To Purchase Energy Efficient Computer Equipment”

Executive Order 12856, “Federal Compliance With Right-to-Know Laws and Pollution Prevention Requirements” (revoked by EO 13148)

Executive Order 12898, “Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations”

Life Cycle Procedures for Project Evaluators



Executive Order 12902, “Federal Efficiency and Water Conservation at Federal Facilities”

Executive Order 12969, “Federal Acquisition and Community Right-to-Know” (revoked by EO 13148)

Executive Order 13101, “Greening the Government Through Waste Prevention, Recycling, and Federal Acquisition”

Executive Order 13123, “Greening the Government Through Efficient Energy Management”

Executive Order 13148, “Greening the Government Through Leadership in Environmental Management”

Executive Order 13149, “Greening the Government Through Federal Fleet and Transportation Efficiency”

Executive Order 13150, “Federal Workforce Transportation”

Graedel, T.E., *Streamlined Life-Cycle Assessment*, Prentice Hall, 1998

Graedel, T.E. and Allenby, B.R., *Design for Environment*, AT&T, 1996

Graedel, T.E. and Allenby, B.R., *Industrial Ecology*, AT&T, 1995

Lave, L. , Hendrickson, C. and Garret, J. Jr., *Economic Input-Output Life Cycle Assessment: A Tool to Improve Analysis of Environmental Quality and Sustainability*, EPA Grant Number R826740

Melnyk, S.A. and Smith, R.T., *Green Manufacturing*, Society of Manufacturing Engineers, 1996

Menke, D.M. and Davis, G.A., *Evaluation of Life Cycle Tools*, Hazardous Waste Branch, Environment Canada, 1996

NASA GRC, *GRC Environmental Programs Manual*

NASA’s Environmental Strategy, *Environmental Excellence for the Twenty-First Century*

“NASA Plan for Implementation of Executive Order 12856, Pollution Prevention and Community Right-to-Know”, October 1995

NASA Policy directive NPD 8820 *Facility Sustainable Design*

Trusty, W.B., *Introducing An Assessment Tool Classification System*, the ATHENA Sustainable Materials Institute, 1999

US Environmental Protection Agency (EPA) *An International Workshop on Life Cycle Impact Assessment Sophistication*, EPA 600-R-00-023

US Environmental Protection Agency (EPA) *Environmental Cost Accounting for Capital Budgeting*, OMB #2070 0138

US Environmental Protection Agency (EPA) *EPA Federal Facility Pollution Prevention Planning Guide*, EPA 300-B-94-012

US Environmental Protection Agency (EPA) *Federal Facility Pollution Prevention: Tools for Compliance*, EPA 600-R-94-154

INFORMATION RESOURCES

Massachusetts Toxic Use Reduction Institute, P2Gems at http://www.p2gems.org/

National Pollution Prevention Roundtable at http://www.glrppr.org/

Ohio EPA, Office of Pollution Prevention at http://www.epa.gov/oppt/
US EPA, *Costing and Life Cycle Analysis for Pollution Prevention Investments: A Practical Users Guide to Environmental Project Financial Analysis at Federal Facilities*

US EPA, *Pollution Prevention Directory,* EPA 742-B-94-005

US EPA, Pollution Prevention Information Clearinghouse (PPIC) at http://www.epa.gov/oppt/library/ppicindex.htm

US EPA, Pollution Prevention Resource Exchange (P2Rx) at http://www.p2rx.org/

US EPA, Significant New Alternatives Policy (SNAP) Program at http://www.epa.gov/Ozone/snap/index.html

APPENDIX A – SUSTAINABLE DESIGN (SD) TOOLS

With regards to the construction / renovation of buildings and structures, a number of potentially useful computer programs have been screened for use at GRC as part of the conceptual design / materials selection process. The use of such programs would need to be incorporated into the current construction project process. The AP/EPP product lists can be viewed on the P2 Website at http://osat-ext.grc.nasa.gov/emo/gov/emo_p2.htm may also be used to identify materials and furnishings to be used as part of the project.

The computer programs that have been screened thus far and may serve their stated purposes at GRC include:

- Federal Methodology for Life-Cycle Cost Analysis (10 CFR 436) and FEDS – this clearly has applications for evaluating life-cycle cost analyses of energy and water conservation. Additional applications need further evaluation
- ATHENA (from the ATHENA Sustainable Materials Institute) – allows comparisons of conceptual building designs in a more broad-based life-cycle framework, and has implications for the selection of building materials
- BEES (Building for Environmental and Economic Sustainability) – implements a systemic evaluation of environmental and economic factors for the selection of building products, meets ASTM standard for life-cycle cost method
- Building Life-Cycle Cost (BLCC) - provides computational support for the analysis of capital investments in buildings
- DISCOUNT – computes discount factors and related present values, future values and related financial parameters
- EMISS – a program designed to estimate air pollution emission factors related to energy use in buildings
- ERATES (Electricity Rates) - calculates the monthly and annual electricity costs for a facility, building, or system
- EnergyPlus - a new generation building energy simulation program designed for modeling buildings with associated heating, cooling, lighting, ventilating, and other energy flows

Additional tools will be screened and short summaries of applications will be included in this chapter. The computer programs as well as the user manuals were made available to GRC personnel electronically.

APPENDIX B – LIFE CYCLE ASSESSMENT (LCA) TOOLS

The LCA tools have been developed for GRC, starting with current life cycle practices. These tools conform with the federal guidelines and NASA policies.

Although the LCA (see Life Cycle Procedures for Project Evaluators flowchart) of individual projects will be performed by project engineers, managers, and other responsible personnel, qualified EMO personnel will develop the LCA tools for specific GRC applications (see LCA Tool Development Procedure flowchart). These tools include a matrix of Life Cycle Assessment Issues to be Resolved that must be completed by the tool development personnel. A Qualitative Life Cycle Assessment Matrix will be the first required LCA tool to be used for project evaluations. Both the Quantitative Life Cycle Assessment and the Life Cycle Assessment Summary Matrix might also be required, per the evaluator's flowchart.

These standard LCA tools will be modified to reflect important issues for each GRC application, while using data and information sources that would be readily available to any evaluator – GRC personnel and/or contractor. During the development of the LCA tools for each application, the EMO developer must complete the Life Cycle Assessment Issues to be Resolved table. The tools will not be considered complete under the developer can place a "Yes" next to every issue question.

The Qualitative Life Cycle Assessment matrix will be the first tool used by project evaluators. This matrix will be both the easiest and fastest matrix to complete by a person knowledgeable about a specific project. If the best alternative reflecting LCA criteria is obvious, then the evaluator need not go further with their analysis. However, if the best alternative is not obvious, then the Quantitative Life Cycle Assessment and the Life Cycle Assessment Summary matrices will also be required.

The Quantitative Life Cycle Assessment will require significantly more information and effort on the part of the evaluator. This matrix will be modified from the standard form to make it possible for evaluators to complete the matrix using available data. Once this matrix is completed, the Life Cycle Assessment Summary matrix will be automatically calculated and completed for the review by the project evaluator.

Both the Qualitative Life Cycle Assessment and Life Cycle Assessment Summary matrices will be designed to be effective decision-making tools for the evaluator. There will be a place on both matrices for the evaluator to indicate their LCA-recommended design.

All of these matrices will be available within a single spreadsheet file. Once completed, the evaluators can easily save their LCA and report their findings to the P2 team electronically through email.

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Life-Cycle Assessment Issues to be Resolved

Sample LCA Category

Note: this assessment will be completed by the LCA developer for each category of assessments to be created (ie. ODCs used as Refrigerants)

Issue	**Yes**	**No**
Have the relevant & applicable life-cycle stages been identified ?	X	
Are data sources available to describe the inputs & outputs for these stages?	X	
Is the available data of an acceptable type & quality to meet the LCA objectives ?	X	
Have the qualitative LCA issues been identified for inclusion on the Qualitative LCA matrix ?	X	
Can the Qualitative LCA Matrix be used effectively as a decision-making tool ?	X	
Have the quantitative LCA issues been identified for inclusion on the Quantitative LCA matrix ?	X	
Does the LCA Summary reflect both the qualitative and quantitative issues ?	X	
Can the LCA Summary Matrix be used effectively as a decision-making tool ?	X	

Qualitative Life-Cycle Assessment Matrix

Sample LCA Category

Note: this assessment matrix will be developed for each category of assessments to be created
(ie. ODCs used as Refrigerants) & completed for each alternative under consideration for any project

Issue	Question	Alt. 1		Alt. 2		Alt. 3		Alt. 4		Alt. 5	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Performance	Does the alternative meet all performance criteria ?										
	Is this a "mission critical" project ?										
Price	Does the cost of the alternative meet budget limitations ?										
	Is this alternative the least-cost alternative for the project ?										
Meeting goals	Is this alternative consistent with the LCA objectives & policies ?										
	Does the alternative minimize the generation of solid wastes ?										
	Does the alternative minimize the generation of hazardous wastes ?										
Material usage	Does the alternative minimize the use of raw materials ?										
	Does the alternative maximize the use of recycled materials ?										
	Does the alternative maximize the use of biobased materials ?										
Resource conservation	Does the alternative minimize the use of water ?										
	Does the alternative minimize the use of energy ?										
	Does the alternative minimize the use of petrochemical fuels ?										
Facility E H & S	Does the alternative minimize the emmissions / releases to air and water ?										
	Does the alternative minimize the health risks to employees ?										
	Does the alternative minimize the safety hazards to employees ?										
Environmental Impacts	Does the alternative minimize the risks of toxic materials to the environment ?										
	Does the alternative minimize the use of materials that can bioaccumulate in environment ?										
	Does the alternative minimize the potential global environmental impacts ?										
Compliance issues	Does the alternative minimize regulatory concerns ?										
	Does the alternative minimize legal liabilities ?										
	Is the alternative consistent with all NASA GRC policies and procedures ?										

Quantitative Life-Cycle Analysis Matrix

Sample LCA Category

Life Cycle Cost Elements	Unit Cost	Direct Purchase		Handling and Transportation		Cost of Using the Product		Cost of Waste Minimization		Treatment and Disposal Cost		Training and Management		Potential Liabilities		Record Keeping		Replacement Costs		Life Cycle Cost
	$/unit	units	$	units	$	units	$	units	$	units	$	units	$	units	$	units	$	units	$	$
PROCESS STEPS																				**$0**
INPUTS			**$0**		**$0**		**$0**		**$0**		**$0**		**$0**		**$0**		**$0**		**$0**	**$0**
Raw Materials (units)			*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*	*$0*
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
Energy Usage			*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*	*$0*
Electricity (kW-hr)			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
Natural Gas (cubic ft)			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
Fuel (gal)			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
Water Usage (gal)			*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		$0		$0	$0
Other Inputs (units)			*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*	*$0*
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0

Quantitative Life-Cycle Analysis Matrix

Sample LCA Category

Life Cycle Cost Elements	Unit Cost	Direct Purchase		Handling and Transportation		Cost of Using the Product		Cost of Waste Minimization		Treatment and Disposal Cost		Training and Management		Potential Liabilities		Record Keeping		Replacement Costs		Life Cycle Cost
	$/unit	units	$	units	$	units	$	units	$	units	$	units	$	units	$	units	$	units	$	$
OUTPUTS			**$0**		**$0**		**$0**		**$0**		**$0**		**$0**		**$0**		**$0**		**$0**	**$0**
Products & Useful Byproducts (units)			*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*	*$0*
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
Releases to Air (units)			*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*	*$0*
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
Releases to Water (units)			*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*	*$0*
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
Solid Wastes (units)			*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*		*$0*	*$0*
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0
			$0		$0		$0		$0		$0		$0		$0		$0		$0	$0

Life-Cycle Assessment Summary Matrix

Sample LCA Category

Note: this assessment matrix will be developed for each category of assessments to be created
(ie. ODCs used as Refrigerants) & completed for each alternative under consideration for any project

		Project Alternatives				
Issue	**Relative Ranking Category**	**1**	**2**	**3**	**4**	**5**
Performance	Meets all performance standards Track records support this alternative					
Price	Within budget limitations The least-cost alternative for the project The lowest LCA cost alternative for the project					
Meeting goals	Maximizes the recycle potential Minimizes the generation of solid wastes Minimizes the generation of hazardous wastes					
Material usage	Minimizes the use of raw materials Maximizes the use of recycled materials Maximizes the use of biobased materials					
Resource conservation	Minimize the use of water Minimizes the use of energy Minimizes the use of petrochemical fuels					
Facility E H & S	Minimizes the emmissions / releases to air Minimizes the emmissions / releases to water Minimizes the health risks to employees Minimizes the safety hazards to employees					
Environmental Impacts	Minimizes the risks of toxic materials to the environment Minimizes the use of materials that can bioaccumulate in environment Minimizes the potential global environmental impacts					
Compliance issues	Minimizes regulatory concerns Minimizes legal liabilities Minimizes concerns about GRC policies and procedures					